

THE GENUS *ACHNANTHES* BORY (BACILLARIOPHYCEAE) IN THE CONTINENTAL WATERS OF CUBA

Liliana TOLEDO¹, Patricio RIVERA² and Hugo BARRALES²

¹ Jardín Botánico de Cienfuegos, Ministerio de la Ciencia, Tecnología y Medio Ambiente, Pepito Tey, C.P. 59 290, Cienfuegos, Cuba. E-mail: jbcfg@perla.cu

² Departamento de Botánica, Universidad de Concepción, Casilla 2407, Apartado 10, Concepción, Chile. Fax: 6 (41) 246005. E-mail: privera@buho.dpi.udc.cl

ABSTRACT — Eight taxa of *Achnanthes* Bory from samples collected in 21 freshwater bodies of Cuba, are characterized and illustrated. *A. exigua* var. *constricta* Hustedt, *A. lanceolata* subsp. *dubia* Grunow, *A. lanceolata* subsp. *rostrata* (Oestr.) Lange-Bertalot and *A. lanceolata* subsp. *frequentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot are reported for the first time from Cuba. Four other taxa, *A. exigua* Grunow, *A. lanceolata* (Bréb.) Grunow var. *lanceolata*, *A. inflata* (Kütz.) Grunow and *A. brevipes* var. *intermedia* (Kütz.) Cleve, are recorded from new localities of the island.

RÉSUMÉ — Huit taxons de *Achnanthes* Bory sont décrits et illustrés à partir d'échantillons d'eau douce pris dans 21 localités à Cuba. *A. exigua* var. *constricta* Hustedt, *A. lanceolata* subsp. *dubia* Grunow, *A. lanceolata* subsp. *rostrata* (Oestr.) Lange-Bertalot et *A. lanceolata* subsp. *frequentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot sont signalés pour la première fois à Cuba. La distribution géographique de quatre autres taxons, *A. exigua* Grunow, *A. lanceolata* (Bréb.) Grunow var. *lanceolata*, *A. inflata* (Kütz.) Grunow et *A. brevipes* var. *intermedia* (Kütz.) Cleve, s'est élargie dans l'île.

RESUMEN — Se describe e ilustra ocho taxa de *Achnanthes* Bory a partir de muestras recolectadas en 21 localidades continentales de Cuba. Cuatro taxa son señalados por primera vez para el área estudiada (*A. exigua* var. *constricta* Hustedt, *A. lanceolata* subsp. *dubia* Grunow, *A. lanceolata* subsp. *rostrata* (Oestr.) Lange-Bertalot y *A. lanceolata* subsp. *frequentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot), y otros cuatro amplian su distribución geográfica (*A. exigua* Grunow, *A. lanceolata* (Bréb.) Grunow var. *lanceolata*, *A. inflata* (Kütz.) Grunow y *A. brevipes* var. *intermedia* (Kütz.) Cleve).

KEY WORDS: freshwater algae, Bacillariophyceae, *Achnanthes*, new records, distribution, Cuba.

INTRODUCTION

This paper presents data about taxa of the genus *Achnanthes* Bory. Investigations by Foged (1984), Maldonado & Genes (1986), Maldonado (1987) and Toledo (1989,

1992 a,b), relate the occurrence of 10 taxa: *A. exigua* Grunow, *A. exigua* var. *heterovalvata* Krasske, *A. brevipes* var. *intermedia* (Kütz.) Cleve, *A. inflata* (Kütz.) Grunow, *A. lanceolata* (Bréb.) Grunow, *A. lanceolata* var. *dubia* Grunow (erroneous identification), including 4 peculiar taxa which are smaller in size: *A. linearis* (W. Sm.) Grunow, *A. microcephala* (Kütz.) Grunow, *A. minutissima* Kützing and *A. minutissima* var. *cryptocephala* Grunow.

Our survey which includes over one hundred samples collected in different Provinces and Counties, reveals the occurrence of 8 taxa, for which the morphology is described and illustrated. Four of these taxa are reported for the first time for the area under study (*A. exigua* var. *constricta* Hustedt, *A. lanceolata* subsp. *dubia* Grunow, *A. lanceolata* subsp. *rostrata* (Oestrup) Lange-Bertalot and *A. lanceolata* subsp. *frecuentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot) and the distribution of four additional taxa is enlarged: *A. exigua* Grunow, *A. lanceolata* (Bréb.) Grunow var. *lanceolata*, *A. inflata* (Kützing) Grunow and *A. brevipes* var. *intermedia* (Kützing) Cleve. The descriptions of some of the taxa in the "minutissima" group (Lange-Bertalot & Krammer, 1989; Krammer & Lange-Bertalot, 1991) will be postponed until the appropriate electron microscopy observations are completed.

MATERIALS AND METHODS

All samples are deposited at the Colección de Muestras de Agua Dulce del Jardín Botánico de Cienfuegos, Cuba. The genus *Achnanthes* Bory was recognized in 21 of the 106 samples examined (Fig. 1). The samples are described as they originally appear on the labels (mval/l = meq l⁻¹).

Municipio Especial Isla de la Juventud (Fig. 1, area nº 1):

- M-88/17a. "Aliviadero de la Presa Cristal; col. Dr. A. Comas; 7/12/1988; detritus".
M-88/19. "Río en la carretera de Gerona a Demajagua, debajo del puente; col. Dr. A. Comas; 7/12/1988; perifiton".

Provincia Pinar del Río (Fig. 1, area nº 2):

- M-73. "Charco en la carretera entre el Valle de Viñales y la ciudad de Pinar del Río (Km 18-19); col. Dr. A. Comas; 16/3/1977; temp. 26° C, ph 6.5".
M-431. "Río entre el Valle de Viñales y la ciudad de Pinar del Río, debajo del puente; col. Dr. A. Comas; 15/12/1980".
M-432b. "Charco cerca del Motel Los Jazmines; col. Dr. A. Comas; 15/12/1980; perifiton".
M-87/1. "Charco en bosque frente a La Bajada, Guanahacabibes; col. Lic. V. Martínez; 8/6/1987; perifiton".
M-87/4. "Laguna Los Negros; col. Lic. V. Martínez; 8/6/1987; perifiton; temp. 31° C, ph 7.4, conductividad 391 µS cm⁻¹, HCO₃²⁻ [sic for HCO₃³⁻] 0.13 mval/l, Ca²⁺ 1.45 mval/l, Mg²⁺ 0.44 mval/l, dureza total 1.89 mval/l, Cl⁻ 2.35 mval/l".
M-87/5a. "Laguna Grande; col. Lic. V. Martínez; 9/6/1987; perifiton; temp. 30° C, ph 9.3, conductividad 108 µS cm⁻¹, HCO₃²⁻ [sic for HCO₃³⁻] 0.36 mval/l, Ca²⁺ 0.44 mval/l, Mg²⁺ 0.22 mval/l, dureza total 0.66 mval/l, Cl⁻ 0.48 mval/l".
M-87/10a. "Laguna Jovero; col. Lic. V. Martínez; 10/6/1987; perifiton; temp. 30° C, ph 7.3, conductividad 267 µS cm⁻¹, HCO₃²⁻ [sic for HCO₃³⁻] 0.29 mval/l, Ca²⁺ 0.4 mval/l, Mg²⁺ 0.44 mval/l, dureza total 0.84 mval/l, Cl⁻ 1.92 mval/l".



Fig. 1. Provinces from which samples were analyzed for *Achnanthes* taxa. N°1: Municipio Especial Isla de la Juventud, 2 loc.; N°2: Provincia Pinar del Río, 7 loc.; N°3: Provincia Matanzas, 4 loc.; N°4: Provincia Cienfuegos, 4 loc.; N°5: Provincia Villa Clara, 1 loc.; N°6: Provincia Camagüey, 1 loc.; N°7: Provincia Granma, 2 loc.

Provincia Matanzas (Fig. 1, area n° 3):

- M-479b. "Laguna del Tesoro, Ciénaga de Zapata; col. Dr. A. Comas; 3/2/1981; perifiton".
- M-482. "Charco cerca de la granja de cocodrilos, boca de la Laguna del Tesoro, Ciénaga de Zapata; col. Dr. A. Comas; 3/2/1981; perifiton".
- M-485. "Charco en camino a San Lázaro, Ciénaga de Zapata; col. Dr. A. Comas; 3/2/1981; perifiton".
- M-493. "Charco en San Lázaro; col. Dr. A. Comas; 3/2/1981; perifiton".

Provincia Cienfuegos (Fig. 1, area n° 4):

- M-82/1. "Naranjito; Noviembre/1982".
- [Unnumbered] "M-El Naranjo, Escambray; Mayo/1982".
- [Unnumbered] "M-San Blas; Octubre/1982".
- [Unnumbered] "M-Rio Lajas; Noviembre/1983".

Provincia Villa Clara (Fig. 1, area n° 5):

- M-87/11. "Acueducto Viena; 1987".

Provincia Camagüey (Fig. 1, area n° 6):

- M-86/21. "Canales de la presa San Miguel; cols. Dr. A. Comas y Dr. Petr Marvan; 2/12/1986; temp. 27° C, alcalinidad 3.1 mval/l, Cl⁻ 5.6 mval/l, dureza total 1.8 mval/l, conductividad 1218 μ S cm⁻¹".

Provincia Granma (Fig. 1, area nº 7):

M-121c. "Charco en camino entre Leonero y puente Guillén; col. Dr. A. Comas; 20/4/1977; detritus; ph 8".

M-124b. "Charco al lado de la carretera, Cayamas; col. Dr. A. Comas; 20/4/1977; detritus".

Pleurax was the resin used for permanent mounting, and it was prepared at the Laboratorio de Cienfuegos (Cuba). Light microscopy observations were done using a Carl Zeiss Jena microscope, model Amplival (Cienfuegos), and a Carl Zeiss Standard RA microscope with phase contrast (Concepcion). Photomicrographs were obtained with a Zeiss C 35 automatic camera, using 100 Asa (21 DIN) Kodak film. The abbreviations VRS = valve with raphe-sternum and VS = valve with sternum, are used in the diagnosis of the taxa.

OBSERVATIONS***Achnanthes exigua* Grunow Figs 2-6**

Grunow in Cleve & Grunow, 1880: 21.

Patrick & Reimer, 1966: 257, pl. 16, figs 21-22.

Lange-Bertalot & Krammer, 1989: 51, pl. 45, figs 4-23.

Synonym: *Achnanthes exigua* Grunow var. *heterovalvata* Krasske, 1923: 193, figs 9a-b.

Valves small, 9-21 µm long and 4-7 µm wide, linear to linear-elliptic, with clearly differentiated ends, rostrate to capitate, narrower than the remainder of the valve. VRS with a linear and narrow sternum, somewhat wider at the central area; central area rectangular, extending to margins of the valve; raphe filiform, with straight and wider proximal poles; striae radial, becoming parallel toward the ends of the valve, 24-30 in 10 µm. VS with a narrow linear sternum, sometimes linear-lanceolate; form and size of the central area variable (missing, expanded toward one or both sides of the valve due to the irregular shortening of some striae); striae radial, 20-24 in 10 µm.

Distribution: Taxon widely distributed in the Island. It was found in M-88/17a Presa Cristal, M-88/19 Río en la carretera de Gerona a Demajagua (Municipio Isla de la Juventud), M-73 charco en carretera entre el Valle de Viñales y la ciudad de Pinar del Río, M-87/4 Laguna Los Negros, M-87/5a Laguna Grande, M-87/10a Laguna Jovero (Provincia Pinar del Río), M-479b Laguna del Tesoro, M-482 boca de la Laguna del Tesoro, M-485 charco en camino a San Lázaro, M-493 San Lázaro (Provincia Matanzas), M-82/1 Naranjito, M-Río Lajas, M-San Blas, M-El Naranjo (Provincia Cienfuegos), M-87/11 acueducto Viena (Provincia Villa Clara), M-121c charco en camino entre Leonero y Puente Guillen, M-124b Cayamas (Provincia Granma).

Previously known for Laguna del Tesoro (Provincia Matanzas), Jardín Botánico de Cienfuegos (Provincia Cienfuegos), Parque Lenin y ciudad Habana (Provincia Habana), (Foged, 1984); Laguna Los Negros, Laguna Vieja (Provincia Pinar del Río), Jardín Botánico Nacional (Provincia Habana), Jardín Botánico de Cienfuegos (Provincia Cienfuegos), (Maldonado y Genes, 1986); Jardín Botánico de Cienfuegos (Provincia Cienfuegos), (Toledo, 1989); Presa Cristal, Río en la carretera entre Gerona y Demajagua

(Municipio Isla de la Juventud), (Toledo, 1992a); Tayabito, Presa Jagüey, Río Saramacuacán, Presa San Miguel, arroyo en camino a Presa Montesito, charco cercano a Presa Jimaguayú (Provincia Camagüey), (Toledo, 1992b).

A. exigua Grunow var. *constricta* Hustedt Figs 7-8

Hustedt in Schroeder, 1921: 145, figs 7-8.

Synonym: *Cocconeis exigua* var. *constricta* (Grunow) Torka, 1909: 8, fig. 3a.

This taxon differs from the type variety only on account of an outstanding central constriction of the valves. Apical axis 13-15 µm; transapical axis 4-5.5 µm; striae 20-24 in 10 µm in the VS and 24-28 in 10 µm in the VRS.

Distribution: In our survey was found only in M-87/10a, Laguna Jovero (Provincia Pinar del Río).

Not previously reported for Cuba.

Achnanthes lanceolata (Bréb.) Grunow var. *lanceolata* Figs 9-10

Basionym: *Achnanthidium lanceolatum* Bréb. in Kützing, F.T., 1849: 54.

Grunow in Cleve & Grunow, 1880: 23.

Krammer & Lange-Bertalot, 1991: 76, pl. 41, figs 1-8, 25.

Valves elliptic to elliptic-lanceolate, 13-26 µm long and 4.5-8 µm wide, with undifferentiated wide and rounded ends. VRS with a linear sternum; central area wide, rectangular; raphe filiform; striae radial, 10-11 in 10 µm, those in the center (generally two) shorter. VS with a linear to linear-lanceolate sternum; in the central zone, and on one side of the valve, there exist a refringent horseshoe-shaped area, simple, forming a shallow depression in the silica wall; striae radial, 10-12 in 10 µm.

Distribution: Found only in sample M-432b, a small pond near Motel Los Jazmines (Provincia Pinar del Río), with only few individuals.

Previously reported by Foged (1984), without illustrations, from Playa Larga in Bahía de Cochinos (Provincia Matanzas) and from Soroa (Provincia Pinar del Río).

Achnanthes lanceolata subsp. *dubia* Grunow Figs 11-12

Grunow in Cleve & Grunow, 1880: 23.

Krammer & Lange-Bertalot, 1991: 76, pl. 42, figs 7-26.

This taxon is characterized by valves broadly elliptic to lanceolate-elliptic, with well differentiated, narrow, subrostrate to rostrate ends. Apical axis 15-19 µm, transapical axis 6-7.5 µm; striae 12-15 in 10 µm in both valves. Horseshoe-shaped area simple, as in var. *lanceolata*.

Distribution: The taxon was found only in sample M-431, Río entre el valle de Viñales y la ciudad de Pinar del Río (Provincia Pinar del Río).

Not previously reported for Cuba. The citation of this taxon for the Provincia de Camagüey (Toledo, 1992b) is erroneous, corresponding to *A. lanceolata* subsp. *frecuentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot.

***Achnanthes lanceolata* subsp. *rostrata* (Oestrup) Lange-Bertalot Figs 13-14**

Basionym: *Achnanthes rostrata* Oestrup, 1902: 253, pl. 1, fig. 11.
Krammer & Lange-Bertalot, 1991: 77, pl. 43, figs 1-14.

Valves broadly elliptic, small, 9-11 µm long and 4.5-5.5 µm wide, with well differentiated, rather wide, subrostrate to rostrate ends. Striae 12-14 in 10 µm in both valves. Horseshoe-shaped area more complicated, partly roofed over by a thin silica hood.

Distribution: This taxon was found abundantly in sample M-87/5a, Laguna Grande (Provincia Pinar del Rio).

Not previously reported for Cuba.

***Achnanthes lanceolata* subsp. *frequentissima* Lange-Bertalot var. *magna* (Straub)
Lange-Bertalot Figs 15-19**

Basionym: *Achnanthes rostrata* var. *magna* Straub, 1985: 135-150.
Lange-Bertalot in Krammer & Lange-Bertalot, 1991: 79, pl. 44, figs 7-9, 24-38.

Valves elliptic, elliptic-lanceolate to lanceolate, with well differentiated, wide and rounded, subrostrate to rostrate ends. Apical axis 14-36 µm, transapical axis 5-8 µm; striae 11-15 in 10 µm in both valves. Horseshoe-shaped area covered by a thin silica hood.

Distribution: A very dense population was found in sample M-87/11, Acueducto Vicna (Provincia Villa Clara), while the sample M-86/21, canales de la Presa San Miguel (Provincia Camagüey), contained only few individuals.

Not previously reported for Cuba.

***Achnanthes brevipes* C. Ag. var. *intermedia* (Kützing) Cleve Figs 20-21**

Basionym: *Achnanthes intermedia* Kützing, 1833: 21.
Cleve, 1895: 193.

Valves linear-lanceolate, 23-51 µm long and 11-14 µm wide, slightly constricted in the central transapical axis, and with broadly rounded ends. VRS with a narrow linear sternum; central area rectangular, extended toward the margins of the valve; proximal ends of the raphe rather wide, both displaced in the same direction; striae slightly radial, 8-10 in 10 µm. VS with an eccentric sternum, curving toward the ends of the valve and ending in an orbicular hyaline area. This area replaces the distal striae. The striae in this valve have the same characteristics as those of the VRS.

Distribution: Found only in a shallow pond in the locality La Bajada-Guanahacabibes, Provincia Pinar del Rio (M-87/1, with only few individuals).

Previously reported by Foged (1984) from Varadero (Provincia Matanzas) and Cienfuegos (Provincia Cienfuegos).

Achnanthes inflata (Kützing) Grunow Figs 22-27

Basionym: *Stauroneis inflata* Kützing, 1844: 105, pl. 30, fig. 22.

Grunow in Cleve & Grunow, 1880: 19.

Patrick & Reimer, 1966: 279, pl. 19, figs 15-16.

Krammer & Lange-Bertalot, 1991: 6, pl. 2, figs 9-12, pl. 3, figs 1-3.

Valves linear-elliptic, 25-45 µm long and 10-14 µm wide, protuberating in the central transapical axis and with rounded, wide, capitate ends. VRS with a linear sternum; central area expanded toward the margins; raphe sinuous, with the proximal raphe ends straight, not protruding into the central area, distal ends curved in the same direction; striae slightly radial all over the valve, 12-13 in 10 µm; areolae rounded, 12 in 10 µm. VS with a linear submarginal sternum; striae parallel, 10-14 in 10 µm, at the ends they become curved, radiate; areolae 12-14 in 10 µm.

Distribution: Very abundant in sample M-87/11, Acueducto Viena (Provincia Villa Clara).

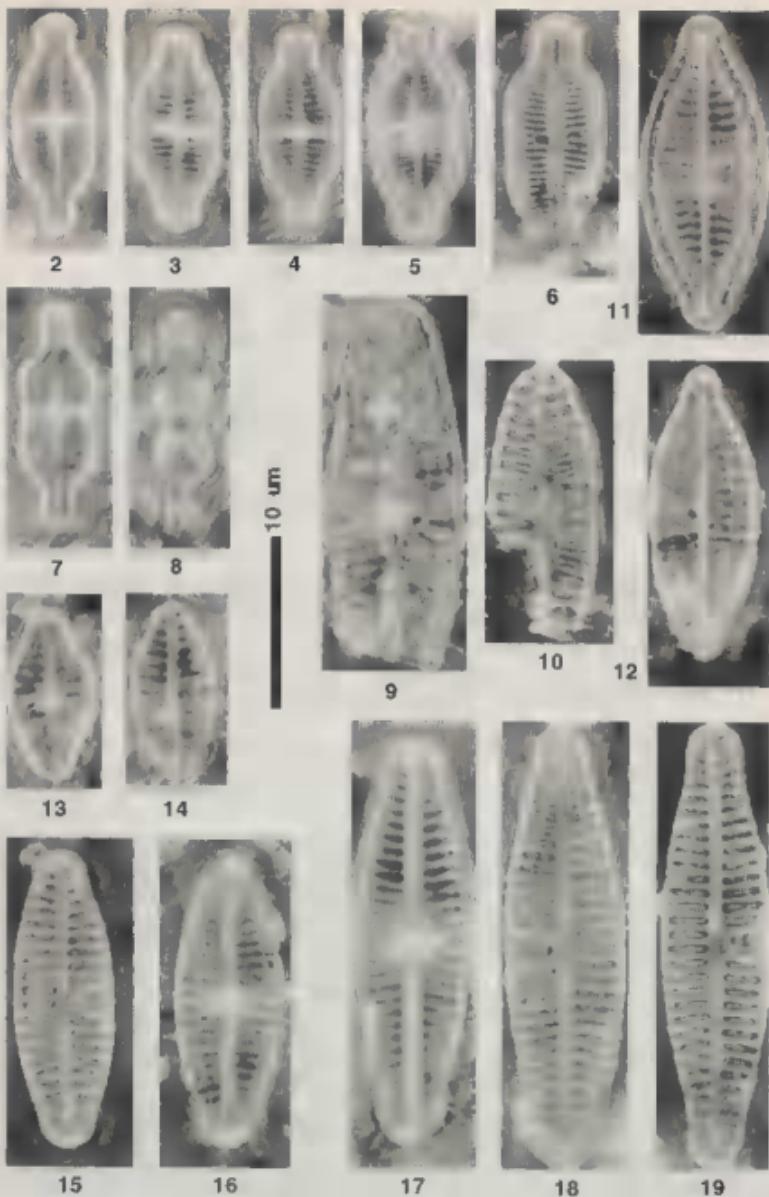
Previously known from Soroa, Provincia Pinar del Rio, also for Jardín Botánico de Cienfuegos, Provincia Cienfuegos and for Varadero, Provincia Matanzas (Foged, 1984).

DISCUSSION

A review of the literature reveals that *A. exigua* is regarded as a very variable taxon. Schoeman & Archibald (1977) consider the varieties *constricta* and *heterovalvata* as synonyms of the variety *exigua*. Krammer & Lange-Bertalot (1991) follow the same criterium, but they place a question mark beside the synonym.

The variety *heterovalvata* differs from the nominate variety only by having a greater number of striae (about 30 in 10 µm) in the valve with raphe sternum. In the abundant material examined from Cuba, the number of striae ranged from 24 to 30 in 10 µm, being always less abundant in the valve with sternum. For this reason we consider the variety *heterovalvata* as synonym of the type variety. We do not follow similar criterium with the variety *constricta*, characterized by the presence of a well defined and relatively deep constriction in the median region of the valves. We found this variety only in one sample collected from Laguna Jovero, Provincia Pinar del Rio, in which all the individuals exhibited constricted valves. We did not observe any individuals fitting the description of the nominate variety, which is of wide occurrence in the freshwater courses of Cuba. However, in the material from the diverse localities we sometimes observed a slight constriction, visible by photonic microscopy, in the central part of the valves of representatives of the variety *exigua*, but never comparable in size nor depth with that of variety *constricta*. No intermediate forms between the extremes were observed.

For *A. lanceolata* numerous infraspecific taxa have been described and often the limits between them are not sufficiently clear. Krammer & Lange-Bertalot (1991) adopted



Figs 2-6. *Achnanthes exigua* Grun. Figs 2-4 = VRS; Figs 5-6 = VS. Figs 2, 5, M-87/11; Fig. 3, M-86/21; Figs 4, 6, M-82/1. Figs 7-8. *Achnanthes exigua* var. *constricta* Hust. M-87/10a. Fig. 7 = VRS; Fig. 8 = VS. Figs 9-10. *Achnanthes lanceolata* (Bréb.) Grun. M 432b. Fig. 9 = VRS; Fig. 10 = VS. Figs 11-12. *Achnanthes lanceolata* subsp. *dubia* Grun. M-431, VS. Figs 13-14. *Achnanthes lanceolata* subsp. *rostrata* (Oestrup) Lange-Bertalot. M-87/11. Fig. 13 = VRS; Fig. 14 = VS. Figs 15-19. *Achnanthes lanceolata* subsp. *frequentissima* Lange-Bertalot var. *magna* (Straub) Lange-Bertalot. M-87/11. Figs 15, 17, 18 = VS; Figs 16, 19 = VRS. Scale = 10 μ m.



20



10 μm

22



23



21



24



25



26



27

10 μm

Figs 20-21. *Achmanthes brevipes* var. *intermedia* (Kütz.) Hust. M-87/1. Fig. 20 = VRS; Fig. 21 = VS. Figs 22-27. *Achmanthes inflata* (Kütz.) Grun. M-87/11. Figs 22, 24, 25 = VRS; Figs 23, 26, 27 = VS. Figs 20-23: scale A; Figs 24-27: scale B. Scales = 10 μ m.

the criterium of "subspecies" in their attempt to differentiate the distinct morphological types. However, in our study of the samples from Cuba it was not difficult to delimit the taxa within this "group". The nominate subsp. does not have differentiated ends, while the subsp. *dubia*, *rostrata* and *frequentissima* (var. *magna*) do have them. In the subsp. *dubia* the ends are narrow, while in *rostrata* they are wide and the valves are smaller. In the variety *magna* the valves are larger, elliptic to lanceolate with wide ends. The material from Cuba of this last variety coincides with the morphological range of forms from Jamaica presented by Krammer & Lange-Bertalot (1991) in figures 34-38.

According to diverse authors, the distinctive features of *A. brevipes* var. *intermedia* are its rounded, non-cuneate ends and the slight constriction of the valves in the central region (Hustedt, 1933; Krammer & Lange-Bertalot, 1991). Different authors have discussed for this taxon, and for others of the same genus, the presence of a hyaline orbicular area, located at the ends of the valve with sternum. Patrick & Reimer (1966) attest that this is a typical feature of *A. temperei*, and that is not to be found in *A. brevipes*. Hendey (1957) uses it as a diagnostic feature in the description of *A. kuwaitensis*, which Giffen (1971) regarded as synonym of *A. brevipes* asserting that in this species, as well as in var. *intermedia* the hyaline orbicular area is frequently found. Archibald (1983) followed this same criterium, and in his figures 69 and 70, corresponding to *A. brevipes* var. *intermedia* the hyaline areas are clearly visible. Krammer & Lange-Bertalot (1991) point out that this feature is absent in the said variety, but characteristic of the related taxon *A. parvula* Kützing (= *A. brevipes* var. *parvula* (Kütz.) Cleve). This species is smaller (10-30 µm long according to Hustedt, 1933 and Krammer & Lange-Bertalot, 1991), its valves are elliptic and have more striae (12-18 in 10 µm) according to Hustedt (*loc. cit.*).

The individuals found in the present study coincide in their morphology, size and striae density with *A. brevipes* var. *intermedia*, and the presence of the hyaline orbicular areas was invariably recognized. There exists a great variability in the morphology of the taxa which compose the group *A. brevipes*, and we consider it of the utmost importance to study pure cultures, in an attempt to clarify the present confusion on the delimitation of the taxa.

A. exigua is, within the genus, the taxon the most widely distributed in the continental waters of Cuba; in the present study this taxon was recognized in samples from all the areas studied. The rest of the taxa have a more restricted distribution.

ACKNOWLEDGEMENTS — Research project partially subsidized by Red Latinoamericana de Botanica (N°95-P2) and Directorship of Research, University of Concepcion, Chile (N°94-111.03-1).

REFERENCES

- ARCHIBALD R.E.M., 1983 — The Diatoms of the Sundays and Great Fish Rivers in the Eastern Cape Province of South Africa. *Bibliotheca Diatomologica*, vol. 1, 362 p., 34 pls, 572 figs (J. Cramer).
- CLEVE P.T., 1895 — Synopsis of the naviculoid diatoms. *Kongliga Svenska Vetenskaps-Akademiens Handlingar* 27 (3): 1-219.
- CLEVE P.T. & GRUNOW A., 1880 — Beiträge zur Kenntnis der arktischen Diatomeen. *Kongliga Svenska Vetenskaps-Akademiens Handlingar* 17 (2): 1-121.

- FOGED N., 1984 — Freshwater and Littoral Diatoms from Cuba. *Bibliotheca Diatomologica*, vol. 5. 243 p., 60 pls. (J. Cramer).
- GIFFEN M.H., 1971 — Marine Littoral Diatoms from the Gordon's Bay, Region of False Bay, Cape Province, South Africa. *Botanica Marina* 14: 1-16.
- GRUNOW A., 1870 — Algae. In: *Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859/SSJ. Botanisch. Theil I*, pp. 1-104, pls 1-11.
- HENDEY N.I., 1957 — III. Marine diatoms from some West African ports. *Journal of the Royal Microscopical Society* 77 (3): 28-85.
- HUSTEDT F., 1933 — Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. In: Dr. L. Rabenhorst's *Kryptogamen-Flora*, vol. VII, Teil 2, pp. 321-432.
- KRAMMER K. & LANGE-BERTALOT H., 1991 — Bacillariophyceae: Achnanthaceae, Kritische Ergänzungen zu *Navicula* (Lineolatae) und *Gomphonema*. Gesamtliteraturverzeichnis Teil 1-4. *Die Süßwasserflora von Mitteleuropa*, 2/4, 437 p., 88 pls. Jena, Gustav Fischer Verlag.
- KRASSKE K., 1923 — Die Diatomeen des Casseler Beckens und seiner Randgebirge nebst einigen wichtigen Funden aus Niederhessen. *Botanisches Archiv* 3 (4): 185-209.
- KÜTZING F.T., 1833-1836 — *Algarum aquae dulcis Germanicarum. Decades. Exsiccatae editae*.
- KÜTZING F.T., 1844 — *Die kieselalgen Bacillarien oder Diatomeen*. Nordhausen, 152 p., 30 pls.
- KÜTZING F.T., 1849 — *Species Algarum. Lipsiae*, 922 p.
- LANGE-BERTALOT H. & KRAMMER K., 1989 — *Achnanthes*, eine Monographie der Gattung mit Definition der Gattung *Cocconeis* und Nachträgen zu den Naviculaceae. *Bibliotheca Diatomologica*, vol. 18, 393 p., 100 pls (J. Cramer).
- MALDONADO S., 1987 — Resultados preliminares sobre las diatomeas (Bacillariophyceae) en la Laguna de Mina Iberia, Baracoa. *Revista del Jardín Botánico Nacional* 3 (1): 13-19.
- MALDONADO S. & GENES E., 1986 — Contribución al conocimiento de las diatomeas (Bacillariophyceae) de agua dulce de Cuba. *Revista del Jardín Botánico Nacional* 3 (2): 45-66.
- OESTRUP E., 1902 (1903) — Flora of Koh Chang. Contributions to the knowledge of the vegetation in the Gulf of Siam by J. Schmidl. Part VII. Freshwater diatoms. *Botanisk Tidsskrift* 25: 28-41, 1 pl.
- PATRICK R. & REIMER C.W., 1966 — *The Diatoms of the United States exclusive of Alaska and Hawaii*. Academy of Natural Sciences of Philadelphia, Monograph 13: Vol. 1, 688 p., 64 pls.
- SCHOEMAN F.R. & ARCHIBALD R.E.M., 1977 — *The Diatom Flora of Southern Africa*. CSIR Special Report Wat 50, n° 3, September 1977. Pretoria.
- SCHRÖDER B., 1921 — Zellpflanzen Östafrikas gesammelt auf der Akademischen Studienfahrt 1910. *Bacillariales. Hedwigia* 63: 117-173.
- STRAUB F., 1985 — Variabilité comparée d'*Achnanthes lanceolata* (Bréb.) Grun. et d'*Achnanthes rostrata* Oestrup (Bacillariophyceae) dans huit populations naturelles du Jura Suisse. I. Approche morphologique. *Bulletin de la Société Neuchâtelloise des Sciences Naturelles* 108: 135-150.
- TOLEDO L., 1989 — Bacillariophyceae del estanque del Jardín Botánico de Cienfuegos. *Acta Botánica Cubana, Academia de Ciencias de Cuba*, 83: 1-12.
- TOLEDO L., 1992a — Bacillariophyceae de Isla de la Juventud, Cuba. *Acta Botánica Cubana, Academia de Ciencias de Cuba*, 85: 1-31.
- TOLEDO L., 1992b — Bacillariophyceae de la Provincia Camagüey, Cuba. *Acta Botánica Cubana, Academia de Ciencias de Cuba*, 88: 1-26.
- TORKA V., 1909 — Diatomeen einiger Seen der Provinz Posen. *Zeitschrift der Naturwissenschaftlich Abteilung Posen, Botanik*, 16:8.